CHOICE BASED CREDIT SYSTEM AND CONTINUOUS ASSESSMENT AND GRADING PATTERN

SYLLABUS FOR

MASTER'S DEGREE PROGRAM
IN
BIO-TECHNOLOGY
(2018-19 ONWARDS)

JSS COLLEGE OF ARTS COMMERCE AND SCIENCE
(An Autonomous College of University of Mysore; Re-Accredited by NAAC with 'A' Grade)

POSTGRADUATE DEPARTMENT OF STUDIES IN BIO-TECHNOLOGY
Ooty Road, Mysore – 570 025, India

POSTGRADUATE DEPARTMENT OF STUDIES IN BIOTECHNOLOGY

Choice Based Credit System and Continuous Assessment and Grading Pattern Syllabus

M.Sc., PROGRAM IN BIOTECHNOLOGY

Scheme of Study – 2018-19 onwards

Credit matrix for Master's Degree Program in Biotechnology

Credits to be earned	I Sem	II Sem	III Sem	IV Sem	Total Credits
Hard Core Course	12	12	12	16	52
Soft Core Course	08	08	04	–	20
Open Elective Course	–	–	04	–	04
Semester Total	**20**	**20**	**20**	**16**	**76**

I SEMESTER			
Course title	**Hard Core(HC)/ Soft Core(SC)**	**Credit pattern (L:T:P)**	**Credits**
Biomolecules and Bioenergetics	HC	3:1:0	4
Bioanalytical Techniques	HC	3:1:0	4
Lab – I	HC	0:0:4	4
Choose any TWO from the following 1. Molecular Genetics 2. Microbiology 3. Cancer Biology 4. Cell Biology	SC	3:1:0	4
	SC	3:1:0	4
NON CREDIT COURSES			
Communication Skills			
		Total credits	**20**
II SEMESTER			
Course title	**Hard Core(HC)/ Soft Core(SC)**	**Credit pattern (L:T:P)**	**Credits**
Molecular Biology	HC	3:1:0	4
Immunology and Immunotechnology	HC	3:1:0	4
Lab – II	HC	0:0:4	4
Choose any TWO from the following 1. Cell Signalling and communication 2. Metabolomics 3. Food and Environmental Biotechnology 4. Pharmaceutical Biotechnology	SC	3:1:0	4
	SC	3:1:0	4
NON CREDIT COURSE			
Employability Skills			
		Total credits	**20**

III SEMESTER			
Course title	**Hard Core(HC)/ Soft Core(SC)/ Open Elective(OE)**	**Credit pattern (L:T:P)**	**Credits**
Bioprocess Engineering and Technology	HC	3:1:0	4
Genetic Engineering	HC	3:1:0	4
Lab – III	HC	0:0:4	4
Choose any ONE from the following 1. Biostatistics, Bioinformatics and Bioentrepreneurship 2. Clinical and Advanced Techniques in Biotechnology	SC	4:0:0	4
Any ONE will be offered 1. Applied Biotechnology * 2. Fundamentals of Bioinformatics* **(For other discipline students)**	OE	4:0:0	4
		Total credits	20
IV SEMESTER			
Course title	**Hard Core(HC)**	**Credit pattern (L:T:P)**	**Credits**
Plant Biotechnology	HC	3:1:0	4
Animal Biotechnology	HC	3:1:0	4
Project Work/Dissertation	HC	0:4:4	8
		Total credits	**16**
		Total credits to be earned for M.Sc. Biotechnology	**76**

∗ Open Elective Course shall be from different discipline of study

1. A student opting I, II and III semester has to appear for at least 12 credits. (Soft core course may be studied any time).
2. Minimum number of students per Soft core course is 15.

L – Lecture – 1 credit = 1 hour

T – Tutorial – 1 credit = 2 hours

P – Practical – 1 credit = 2 hours

ASSESSMENT:

Continous Assessment: C1 – 15% & C2 – 15% (at the end of 8th and 16th week respectively)

Assessment	IA Test (20 Marks)	Assignment (5M)		Total (25 Marks)	Total reduced to 15 Marks
		a - Collection of material - 2.5 Marks	b - Prepartion of report - 2.5 Marks		
C1					
C2					

Semester End Assessment: C3 – 70% – By written exam.

Conversion of grades in to credits should be based on relative evaluation calculations.

Program: M.Sc. Biotechnology

Program outcomes (PO):

PO1: To make the students develop interpersonal skills, written and oral communication and also to improve their body language and eye contact during presentations.

PO2: To train the students in group discussions to develop leadership qualities and to respect the others idea and take the decisions for the welfare of society.

PO3: To teach the students not to demoralize the others ideas and not to differentiate the intelligent and the ignorant, poor and the rich and to uphold the moral values in the society.

PO4: Upon completion of course students will have the ability to design the experiments to solve the current problems in the society related to health, environment and industries.

PO5: To make the students competent enough to write the research papers, project proposals and application of mathematics in understanding biological science.

Program Specific Outcomes (PSO):

PSO1: To make the students understand the nature, bio-molecules, their analysis and application in day to day life, so that we are transforming knowledge from nature to lab and lab to beside.

PSO2: Higher studies like M.Phil and Ph.D can be pursued to attain research positions.

PSO3: Various examinations such as CSIR-NET, ARS-NET GATE, ICMR, DBT and many other opens channels for career development.

PSO4: Students have various opportunities in different industrial sector.

PSO5: Several career opportunities are available for students with biotechnology background abroad

PSO6: In practical we teach the students to follow the standard operating procedures of the equipment, troubleshooting the problems and analyse and interpretation of data.

PSO7: To train the students regarding bio-safety in handling corrosive, explosive and radioactive and bio-hazardous compounds.

I SEMESTER
BIOMOLECULES AND BIOENERGETICS (HARD CORE) - 48 Hrs

COURSE CODE: BTA040

Course Outcome

CO1-Study of different biomolecules

CO2-Metabolism and their regulation

CO3-Enzymes and their role in metabolism

CO4- Application of thermodynamics to understand the basic concepts of life.

Unit – I **12 Hrs**

Chemical basis of life; Composition of living matter; Water – properties, pH, ionization and hydrophobicity; Emergent properties of biomolecules in water; Biomolecular hierarchy; Macromolecules; Molecular assemblies; Structure-function relationships

Amino acids – structure and functional group properties; Peptides and covalent structure of proteins; Ramchandran's plot; Elucidation of primary and higher order structures; Evolution of protein structure; Structure-function relationships in model proteins like ribonuclease A, myoglobin, hemoglobin and chymotrypsin.

Unit – II **12 Hrs**

Enzyme catalysis – general principles of catalysis; Quantitation of enzyme activity and efficiency; Enzyme characterization and Michaelis-Menten kinetics; activation, inhibition (reversible & irreversible) and covalent modification; Single substrate enzymes; Bisubstrate reaction (ping-pong and sequential), Applications of enzymes (food& Pharmacy).

Unit – III **12 Hrs**

Sugars - mono, di, and polysaccharides; Suitability in the context of their different functions- cellular structure, energy storage, signaling; Glycosylation of other biomolecules - glycoproteins and glycolipids; Lipids - structure and properties of important members of storage and membrane lipids; lipoproteins

Unit – IV **12 Hrs**

Bioenergetics-basic principles; Equilibria and concept of free energy; Coupled processes; Glycolytic pathway; Kreb's cycle; Oxidative phosphorylation; Photophosphorylation; Elucidation of metabolic pathways; Logic and integration of central metabolism; entry/ exit of various biomolecules from central pathways; Principles of metabolic regulation; Regulatory steps;
Nucleosides, nucleotides, nucleic acids - structure, diversity and function

Texts/References

1. V.Voet and J.G.Voet, Biochemistry, 3rd edition, John Wiley, New York, 2004.
2. A.L. Lehninger, Principles of Biochemistry, 4th edition, W.H Freeman and Company, 2004.
3. L. Stryer, Biochemistry, 5th edition, W.H. Freeman and Company, 2002.

BIOANALYTICAL TECHNIQUES (HARD CORE) - 48 HRS

COURSE CODE: BTA050

Course Outcome

CO1-To understand the separation of molecules by different chromatography, centrifugation and electrophorotic techniques

CO2-Analysis and characterization of molecules by spectroscopy techniques

CO3-Use of radioactive material in understanding metabolic pathways

Unit- I **12 Hrs**

Basic Techniques

Buffers; Methods of cell disintegration; Enzyme assays and controls; Detergents and membrane proteins; Dialysis, Ultrafiltration and other membrane techniques

Spectroscopy Techniques

UV, Visible and Raman Spectroscopy; Theory and application of Circular Dichroism; Fluorescence; MS, MALDI-TOF; NMR and Plasma Emission spectroscopy; Protein crystallization; Theory and methods; API-electrospray; Peptide Synthesis.

Imaging techniques: Compound microscope, fluorescent, phase contrast, TEM, SEM, cryo-electron microscope

Unit-II **12 Hrs**

Chromatography Techniques

TLC and Paper chromatography; Chromatographic methods for macromolecule separation - Gel permeation, Ion exchange, Hydrophobic, Reverse-phase and Affinity chromatography; HPLC and FPLC; Criteria of protein purity

Electrophorotic techniques

Theory and application of Polyacrylamide and Agarose gel electrophoresis; Capillary electrophoresis; 2DElectrophoresis; Gradient electrophoresis; Pulsed field gel electrophoresis

Unit- III **12 Hrs**

Centrifugation

Basic principles; (RCF, Sedimentation coefficient etc); Types of centrifuge -Microcentrifuge, High speed & Ultracentrifuges; Preparative centrifugation; Differential & density gradient centrifugation; Applications (Isolation of cell components); Analytical centrifugation; Determination of molecular weight by sedimentation velocity & sedimentation equilibrium methods

Unit- IV **12 Hrs**

Radioactivity

Radioactive & stable isotopes; Pattern and rate of radioactive decay; Units of radioactivity; Measurement of radioactivity; Geiger-Muller counter; Solid & Liquid scintillation counters (Basic principle, instrumentation & technique); Brief idea of radiation dosimetry; Cerenkov radiation; Autoradiography; Measurement of stable isotopes; Falling drop method; Applications of isotopes in biochemistry; Radiotracer techniques; Distribution studies; Isotope dilution technique; Metabolic studies; Clinical application; Radioimmunoassay

Texts/References

1. Freifelder D., Physical Biochemistry, Application to Biochemistry and Molecular Biology, 2nd Edition, W.H. Freeman & Company, San Fransisco, 1982.
2. Keith Wilson and John Walker, Principles and Techniques of Practical Biochemistry, 5th Edition, Cambridge University Press, 2000.

3. D. Holme& H. Peck, Analytical Biochemistry, 3rd Edition, Longman, 1998.
4. R. Scopes, Protein Purification - Principles & Practices, 3rd Edition, Springer Verlag, 1994.
5. Selected readings from Methods in Enzymology, Academic Press.

LAB – I (HARD CORE)

COURSE CODE: BTA060

Course Outcome

CO1 - Course objective is to introduce the students to the fundamental experiments in the field of Biochemistry, Microbiology and Genetics.

CO2 - Students get the insight to operate simple equipments like colorimeter and spectrophotometer.

CO3 - Identification of microorganisms by morphology and staining techniques. Study of growth kinetics.

CO4 - In genetics students are exposed to know about culture and maintenance of *Drosophila melanogaster* (model organism), Study of mutants, salivary gland chromosome and karyotyping techniques.

Practicals/ Experiments

1. Good laboratory practices
2. Measurement of pH
3. Preparation buffers and solutions
4. Determination of pKavalues of amino acids
5. Estimation of reducing sugar by DNS method
6. Estimation of proteins by Lowry's method
7. Ascending, descending and circular paper chromatography for separation of amino acids (1D & 2D)
8. TLC of amino acids/lipids (1D & 2D)
9. HPLC
10. Estimation of ascorbic acid by DNPH method
11. Estimation of urea
12. Estimation of Phosphate
13. Gel electrophoresis- native and SDS-PAGE and determination of molecular weight of proteins
14. Salivary amylase assay, time kinetics, specific activity, determination of optimum temperature and pH; Effect chloride ions on salivary amylase activity
15. Determination of Km and Vmax. and activation energy for an acid phosphatase (from potato)
16. Effect of inhibitors on enzyme activity
17. Purification of amylase from sweet potatoes: Extraction, ammonium sulphate fractionation, gel filtration. Monitoring of enzyme activity, % activity and % recovery during purification
18. Preparation of liquid and solid media for growth of microorganisms
19. Isolation and maintenance of organisms by plating, streaking and serial dilution methods, slants and stab cultures, storage of microorganisms
20. Isolation of pure cultures from soil and water
21. Growth, growth curve; measurement of bacterial population by turbidometry and serial dilution methods. Effect of temperature, pH, carbon and nitrogen sources on growth.
22. Microscopic examination of bacteria, yeast and molds and study of organisms by gram stain, acid fast stain and staining for spores.
23. Assay of antibiotics and demonstration of antibiotic resistance.
24. Culture of Drosophila melanogaster and Observation of drosophila mutants
25. Isolation of salivary gland chromosomes
26. Biotech Industry and/ or R & D institution visit/s

MOLECULAR GENETICS (SOFT CORE) – 48 Hrs

COURSE CODE: BTA230

Course Outcome

CO1- To understand the molecular mechanism of inheritance

CO2-Mutation and DNA repair mechanism

CO3-Gene mapping and study of chromosomal abnormalities

CO4-Phylogenetics and micro-evolution

CO4-Development of an organism

Unit- I **12 Hrs**

Laws of inheritance in haploid organisms- *Chlamydomonas* and *Neurospora*, uniparental, maternal and cytoplasmic inheritance in yeast, *Neurospora*, paramecium and plants

Genomic organization: Prokaryotes, eukaryotes, viral genome, extrachromosomal genome-plasmids, mitochondria & chloroplast, repetitive elements- LINES and SINES, simple sequence repeats

Mobile genetic elements: discovery, insertion sequence in prokaryotes, complex transposons (Tn10, Tn5, Tn9 and Tn3 as examples), mechanisms, control, consequences and applications of transposition by simple and complex elements.

Unit – II **12 Hrs**

Mutation: Types, causes and detection, mutant types – lethal, conditional, biochemical, loss of function, gain of function, germinal verses somatic mutants, Molecular basis of mutations,insertional mutagenesis

Recombination: Homologous and non-homologous recombination, Holliday model, site-specific recombination

DNA Repair: Mechanism of genetic repair- direct repair, photo reactivation, excision repair, mismatch repair, post-replicative recombination repair, SOS repair

Unit-III **12 Hrs**

Gene mapping methods: Linkage maps, tetrad analysis, mapping with molecular markers, mapping by using somatic cell hybrids, development of mapping population in plants.

Microbial genetics: Methods of genetic transfers – transformation, conjugation, transduction and sex-duction, mapping genes by interrupted mating, fine structure analysis of genes.

Quantitative genetics: Polygenic inheritance, heritability and its measurements, QTL mapping.

Unit-IV **12 Hrs**

Genes and development: Model systems for studying development- *Drosophila, Caenorhabditis, Arabidopsis*.Genetic control of development in Drosophila: anterioposterior axis specification, role of maternal genes, segmentation of larval body, gap genes, pair rule genes, homeotic genes, complex gene interaction in development, sequential gene action. Floral meristems and floral development in *Arabidopsis.*

Human Genetics: Human chromosomes, karyotype – construction, characteristics, staining techniques and nomenclature; chromosomal abnormalities – sex chromosomal and autosomal, inherited disorders, genetic counselling, gene therapy; Human Genome Project, Human Genome Map.

Population Genetics: Genetic variation, Hardy-Weinberg Law, random mating, genetic frequency, natural selection, genetic drift, migration, genetic equilibrium.

Evolution:Molecular basis of evolution, Molecular clock, Molecular phylogenetics

Reference Books

1. Genetics. Strickberger, M. W., Prentice Hall of India Pvt. Ltd.
2. Genetics – A Molecular Approach. Brown, T. A. Chapman and Hall.
3. Genes VII. Lewin, B. Pearson Education International. 2003.
4. Genetics- A Conceptual Approach. Benjemin A Pierce.

CANCER BIOLOGY (SOFT CORE) – 48 Hrs

COURSE CODE:

Course Outcome

CO1-Understanding the normal and cancerous cell

CO2-Protooncogens, tumor suppressor genes and apoptotic genes – regulation

CO3-Diagnosis and treatment of cancer

Unit-I

Cancer Biology: **12 Hrs**

Introduction, historical perspective, classification, Carcinogenesis, cancer initiation, promotion and progression, Cancer cell cycles, Genomic instability, Apoptosis, Genes and proteins as players in apoptosis, DNA viruses/ cell immortalization.

Unit-II **12 Hrs**

Cancer Genes I: Oncogenes and signal transduction

Cellular proto-oncogenes, oncogene activation, Growth factors, growth factor receptors, signal transduction , Transcription, Transcription factors and cancer, Retroviral oncogenes, Tumor suppressor, Tumor suppressor gene pathways, DNA methylation, epigenetic silencing of suppressor genes.

Unit-III **12 Hrs**

Understanding Cancer as a Disease: natural history of cancer development

Free radicals, antioxidants and metabolic oxidative stress and cancer, Epidemiology of selected cancers, Gene rearrangements, detecting oncogene abnormalities in clinical specimens, Cell: cell interactions, cell adhesion, angiogenesis, invasion and metastasis, Antiangiogenic therapy of cancer.

Unit-IV **12 Hrs**

Current concepts in cancer therapy

Strategies of anticancer chemotherapy, Strategies of anticancer gene therapy/translating therapies from the laboratory to the clinic, Gene discovery in cancer research, cancer genome anatomy project , Cancer immunity and strategies of anticancer immunotherapy, stem cells and their applications in cancer therapy.

Reference Books

1. Molecular Biology of the Cell. Bruce Alberts

MICROBIOLOGY (SOFT CORE) – 48 Hrs

COURSE CODE: BTA240

Course Outcome

CO1- To understand the microbial taxonomy

CO2-Handling, preservation and sterilization of microbes

CO3-Microbial interactions with different hosts

CO4-Application of microorganisms in the field of agriculture, environment and health sciences

Unit-I **12 Hrs**

Microbial Diversity & Systematics

The beginning of microbiology: The discovery of the microbial world – Hook, Anton van Leeuwenhoek and Cohn; Contribution of Pasteur and Koch. Development of pure culture methods; the enrichment culture methods. Methods in Microbiology: Pure culture techniques; the theory and practice of sterilization.

Classical and modern methods and concepts; Domain and Kingdom concepts in classification of microorganisms; Criteria for classification; Classification of Bacteria according to Bergey's manual; Molecular methods such as Denaturing Gradient Gel Electrophoresis (DGGE), Temperature Gradient Gel Electrophoresis (TGGE), Amplified rDNA Restriction Analysis and Terminal Restriction Fragment Length Polymorphism (T-RFLP) in assessing microbial diversity; 16S rDNA sequencing and Ribosomal Database Project.

Unit-II **12 Hrs**

Microbial Growth & Physiology

Ultrastructure of Archaea (Methanococcus); Eubacteria (*E.coli*); Unicellular Eukaryotes (Yeast) and viruses (Bacterial, Plant, Animal and Tumor viruses); Microbial growth: Batch, fed-batch, continuous kinetics, synchronous growth, yield constants, methods of growth estimation, stringent response, death of a bacterial cell. Factors affecting growth like temperature, acidity, alkalinity, water availability and oxygen. Microbial physiology: Physiological adoption and life style of Prokaryotes; Unicellular Eukaryotes and the Extremophiles (with classical example from each group)

Unit-III **12 Hrs**

Microbial Interactions and Infection

Host–Pathogen interactions; Microbes infecting humans, veterinary animals and plants; Pathogenicity islands and their role in bacterial virulence. Chemotherapy/antibiotics: Types, mode of action, resistance to antibiotics.

Unit-IV **12 Hrs**

Microbes and Environment

Role of microorganisms in natural system and artificial system; Influence of Microbes on the Earth's Environment and Inhabitants; Ecological impacts of microbes; Symbiosis (Nitrogen fixation and ruminant symbiosis); Microbes and Nutrient cycles; Microbial communication system; Quorum sensing; Microbial fuel cells; Prebiotics and Probiotics.

Texts/References

1. Pelczar MJ Jr., Chan ECS and Kreig NR., Microbiology, 5th Edition, Tata McGraw Hill, 1993.
2. Maloy SR, Cronan JE Jr., and Freifelder D, Microbial Genetics, Jones Bartlett Publishers, Sudbury, Massachusetts, 2006.

3. Crueger and A Crueger, (English Ed., TDW Brock); Biotechnology: A textbook of Industrial Microbiology, Sinaeur Associates, 1990.
4. G Reed, Prescott and Dunn's, Industrial Microbiology, 4th Edition, CBS Publishers, 1987.
5. M.T. Madigan and J.M. Martinko, Biology of Microorganisms, 11th Edition, Pearson Prentice Hall, USA, 2006.

CELL BIOLOGY (SOFT CORE) – 48 Hrs

COURSE CODE:

Course Outcome

CO1-Understanding the structure and function of bacterial, plant and animal cell

CO2-Cell signalling and communication

CO3-Study of growth factors and their function

CO4-Tumor biology of a cell

Unit-I **12 Hrs**

Membrane and membrane phenomenon: Membrane structure and principles of organization, Membrane proteins, glycoproteins and glycolipids, specialization of plasma membrane, transport across cell membrane – types of transport, ion channels, active transport and ion pumps, symport, antiport, plant and prokaryotic membrane transport proteins. Cell organelle and membrane proteins: Mechanism and regulation of vesicular transport, Golgi and post golgi storing, receptor mediated endocytosis.

Unit-II **12 Hrs**

Microfilament, cell motility and cell shape: actin, actin architecture and assembly, myosin, muscle contraction, microtubules structure and dynamics, microtubule associated protein, cilia, flagella, intermediate filaments.

Multicellularity: Extracellular matrix, hyaluronan and proteoglycan, matrix proteins and their receptors, adhesive proteins, cell junctions, structure and function of plant cell wall.

Cellular signaling: Extra cellular signaling, G-protein linked receptors, role of cAMP, receptor tyrosine kinases, Ca^{2+} as a second messenger, multiplex signaling pathways, insulin receptor and regulation of blood glucose, regulation of cell surface receptors and transcription factors in signaling pathways, Chemical messenger – peptide and steroid hormones, mechanism of hormone action.

Unit-III **12 Hrs**

Growth factor: Growth factor structure (PDGF, VEGF), mechanism of action (PDGF, VEGF), receptors, signal transduction, plant growth factors and hormones – auxins, cytokinins and other

Cell Cycle: General strategy of cell cycle, discrete cell cycle events, cell cycle control, early embryonic cell cycle, yeast cell cycle, molecular genetics of cell cycle control, cyclins, cyclin dependent kinase, inhibitors, cell division control in multicellular organism, apoptosis.

Unit-IV **12 Hrs**

Tumor biology: Retroviruses, retro viral transformation of host, development and causes of cancer, proto-oncogene, conversion from proto-oncogene to oncogene, tumor suppressor gene, role of p53 in cancer, cell culture uses in research, molecular medicine and cancer.

Nerve cells: Action potential, voltage gated ion channels, nicotinic acetylcholine receptor, other neurotransmitters and their transporters, sensory transduction – the visual and olfactory system.

Reference Books

1. Molecular Biology of the Cell. Alberts, B., *et al.,* 4th Edition. Garland Publ. Inc.
2. Molecular Cell Biology. 5th Edn. Lodish, H., *et al.,* W H Freeman.
3. Genes VII. Lewin, B. Pearson Education International.
4. Cell and Molecular Biology. Karp, J. John Wiley and Sons Inc.

NON CREDIT COURSE

COURSE CODE:
Course Outcome
CO1-Interpersonal skills (body language, eye contact)
CO2-Presentation skills
CO3-Writing emails, research papers and proposals and business reports

Communication Skills Module

Business Etiquette – Video Conferencing (VC): Introduction to Video Conferencing; Concept & uses of VC; VC Etiquette

Business Communication: Seven Cs of communication: Complete, Courteous, Considerate, Clear, Concise, Concrete, Correct; Verbal/ Nonverbal Communication

Writing Process: Identifying objective; Categorizing Information; Organizational Patterns; Designing document; Memo writing; Revision checklist; Releasing document

Business Proposal & Report Writing: Types of Proposals; Top-Down & Bottom-Up Approach; Study of Technical Bid & Cost Bid; Transmittal Letters; Formal Reports (Short and Long); Types of graphics & illustrations; Business Report Templates; Study of Sample Proposals;

Project Report Writing: Project Charter; Project Plan; Gant Chart; Activities List; Resources List; Risks List, Project Status Report; Project Closure Report; Types of graphics & illustrations; Study of Project Report Templates

Email Writing: Problems resulting out of emails; Contents of email, Importance of a good subject line; Dos and Don'ts; Using your email software to its maximum; Setting up signatures; Setting up accounts; Creating HTML stationary; Creating email templates for common emails; Using short mails for internal communication; Importance of acknowledging emails; Creating folder structure for easily accessing emails; Care to be taken while deleting emails, Archiving emails; Comparison of emails and letters; Writing typical emails, sending point-wise reply to emails

Cross-Cultural Training: Cross-Cultural Sensitivity; American, European, Australian, Middle-east and South-East Asian countries culture training; Cultural Foundations; Cross Cultural Communication; Communication Styles; Comparative Values (American – Indian); Regional Dialects; Cross-Cultural Customer Attitude & Expectations

Interpersonal Skills: Introduction & Importance of Interpersonal Skills; Cost of Poor interpersonal skills; Standing up for self assertiveness; Strategies to achieve self-assertiveness; Managing conflicts, disputes; Dealing with Diversity Interpersonal Relationship and influence

II SEMESTER

MOLECULAR BIOLOGY (HARD CORE) – 48 Hrs

COURSE CODE: BTB020

Course Outcome

CO1- The student will get an idea about the genomic organization of prokaryotes and eukaryotes.

CO2-Obtain in depth knowledge of genetic code, DNA replication and transcription.

CO3-Understand principles, concepts of translation, post translation mechanism

CO4-Regulation of gene expression in prokaryotes and eukaryotes

CO5-Gain the insight into molecular mechanism of antisense molecules, inhibition of splicing and application of antisense and ribozyme technologies.

Unit-I **12 Hrs**

Genome organization:Organization of bacterial genome; Structure of eukaryotic chromosomes; Role ofnuclear matrixin chromosome organization and function; Matrix binding proteins; Heterochromatin and Euchromatin; DNA reassociation kinetics (Cot curve analysis); Repetitive and unique sequences; Satellite DNA;DNA melting and buoyant density; Nucleosome phasing; DNase I hypersensitive regions

DNA topology: Closed and super coiled DNA, DNA topoisomerases,

DNA replication: Enzymes in DNA replication, DNA Pol I, II III, replication in single stranded DNA viruses, replication in prokaryotes, eukaryotic DNA replication, eukaryotic polymerases, role of other proteins and enzymes in replication, fidelity of replication, replication of mitochondrial DNA, inhibitors of replication.

Unit- II **12 Hrs**

Genetic code: Elucidation, Contributions of Khorana and others, triple binding assay, Wobble hypothesis.

Transcription: Transcription unit, RNA polymerase in prokaryotes, mechanism of transcription-initiation, elongation and termination. Eukaryotic transcription - eukaryotic RNA polymerase, transcription factors, initiation, elongation and termination of transcription, inhibitors of transcription; post transcriptional modifications – capping, polyadenylation, splicing, introns and exons. Structural organization of mRNA, tRNA and rRNA, nuclear export of mRNA and mRNA stability

Unit-III **12 Hrs**

Translation: Molecular anatomy and biogenesis of ribosome, partial reconstitution experiments; Amino acid activation- amino acylation of tRNA; prokaryotic and eukaryotic translation– mechanism of initiation, elongation and termination, inhibitors of translation, post translational modifications, protein glycosylation.

Protein localization: Synthesis of secretory proteins and membrane proteins; import into nucleus, mitochondria, chloroplast and peroxisomes.

Regulation of gene expression in Prokaryotes: Basic control circuits, positive and negative regulation; Operon concept – *lac*, *ara* and *trp* operons- catabolite repression, regulatory elements in prokaryotes, attenuation, antitermination, regulation of gene expression in Bacteriophage.

Unit-IV **12 Hrs**

Regulation of gene expression in Eukaryotes: *cis* control elements – promoters, enhancers, *trans* acting factors, DNA binding motifs of transcription factors, mechanism of regulation by transcription factors, NFkB histone acetyl transferase and deacylase, hormonal regulation of gene expression, post transcriptional control.

Antisense RNA and ribozymes: Molecular mechanism of antisense molecules, inhibition of splicing, disruption of RNA structure, hammerhead, hairpin ribozymes, Application of antisense and ribozyme technologies. RNA interference, RNA induced gene silencing.

Reference Books

1. Molecular Biology. Freifelder, D. Narosa Pub House.
2. Advance Molecular Biology. Twyman, R. M. Viva Book Pvt. Ltd.
3. Molecular Biology. JD Watson
4. Molecular Biology of the Cell. Bruce Alberts.
5. Genes, Benjamin XII ,2017

IMMUNOLOGY AND IMMUNOTECHNOLOGY (HARD CORE) – 48 Hrs

COURSE CODE: BTB050

Course Outcome

CO1- Study basic concepts of immunology

CO2- MHC and their role in transplantion

CO3-Cytokines and their role in immune system

CO4-Tumor immunology

CO5-Autoimmune diseases

CO6-Hypersensitivity

CO7-Vaccine production.

Unit-I **12 Hrs**

Immune system: Structure, functions and organization of cells and organs involved in immune systems – T cells, B-cells, macrophages, Eosinophils, Neutrophils, Mast cells; bone marrow, spleen, thymus, lymph node, peyer's patch; Infections and immune responses – Innate immunity, acquired immunity; clonal nature of immune response; Immunohaematology – blood groups antigens, blood transfusion and Rh incompatibilities.

Antigens: Types, haptens, adjuvants, antigenic specificity.

Antibodies:Structure of immunoglobulins, heterogeneity, sub-types – iso-, allo- and idio- types and their properties

Unit-II **12 Hrs**

Complements: Structure, components, properties and functions of complement pathways, biological consequences of complement activation; Immunological diversity;

Effector mechanism: T-cell cloning, mechanism of antigen recognition by T-cells and B-lymphocytes and their properties, receptors and related diseases.

Role of class II MHC molecules in T-cell cloning, antigen specific and alloreactive T-cell cloning, applications of T-cell cloning in understanding relevant antigens and T-cell subtypes; T-cell cloning in vaccine development

MHC and Tumor immunology: Structure and function of MHC and the HLA system; regulation of Ir-genes; Tumor immunology– Tumor specific antigens, Immune response to tumors, theory of surveillance, immune diagnosis of tumor; Tumor markers – Alpha fetofoetal proteins, carcinoembryonic antigen

Unit-III **12 Hrs**

Immune responses and Transplantation: HLA and tissue transplantation; Tissue typing methods for organ and tissue transplantation in humans; Graft versus host rejection, Host versus graft rejection; Xenotransplantation; Immunosuppression theory; Autoimmune diseases – Hashimoto's disease, Systemic lupus erythematosis, Multiple sclerosis, Myasthenia gravis, Rheumatoid arthritis and the remedies.

Allergy: Type I – Antibody mediated – Anaphylaxis, Type II – antibody dependent – Cytolytic and Cytotoxic, Type III – Immune complex mediated reactions– Arthus reaction, serum sickness, Type IV– Cell mediated hypersensitivity reaction– Tuberculin type.

Unit-IV **12 Hrs**

Lymphokines and Cytokines– assay methods, related diseases; Immunological tolerance; production of interleukins and interferons– applications.

Immunizations: Conventional vaccines, sub-unit vaccines, DNA vaccines, toxoids, antisera; common immunization – small pox, DPT, hepatitis, polio, measles

Reference Books

1. Immunology. Roitt, Gower Medical Publisher.
2. Fundamental Immunology. Paul W E Raven Press.
3. Immunology. Kuby
4. Immunology, JanewasTraves, Walpart, SHlomehik. Churchill Livingstone.
5. An introduction to Immunology. Rao, C. V. Nasora pub house.
6. Immunology – A short course. Coico, R., Sunshine, G. and Benjamini, E. John Wiley and sons.
7. Cellular Interactions and Immunobiology. BIOTOL series. Butterworth-Heinemann.

LAB – II (HARD CORE)

COURSE CODE: BTB060

Course Outcome

CO1-Students are trained to get the skills in the field of Molecular biology and Genetic engineering

CO2- , Isolation and purification of nucleic acids and their quantification

CO3-Study of antigen and antibody interactions.

CO4 -Preparation of wine and analysis of food samples

Practicals/ Experiments

1. Identification of normal and abnormal human karyotype
2. Localization of Barr bodies
3. Estimation of free fatty acids by titrametric method
4. Saponification value for commercial oil samples
5. Determination of iodine value of an oil
6. Determination of total carbohydrates by phenol-sulphuric acid method
7. Estimation of cholesterol
8. *In vitro* transcription
9. Total RNA extraction
10. Estimation of DNA by Diphenylamine (DPA) method
11. Estimation of RNA by orcinol method
12. Isolation of DNA different samples: plant leaves, coconut endosperm, yeast, animal tissues
13. Determination of purity and concentration of isolated DNA using spectrophotometer
14. Agarose gel electrophoresis of DNA
15. Analysis of microbial quality of foods – Litmus test, catalase test and dye reductase test in milk, estimation of lactic acid in milk
16. Preparation of wine
17. Estimation of percentage of alcohol in wine
18. Chemical method to differentiate between ethanol from methanol
19. Estimation of total acids in wine
20. Conjugation
21. Phage titration
22. Preparation of antigen and antibody production
23. Purification of IgG/IgY
24. Slide agglutination test/blood grouping
25. Antibody labeling
26. Immunoprecipitation test- ODD
27. ELISA for quantification of an antigen
28. Lymphocyte preparation
29. Rossette assay
30. Rocket immunoelectrophoresis

Biotech Industry and/ or R & D institution visit

CELL SIGNALLING AND COMMUNICATION (SOFT CORE) – 48 Hrs

COURSE CODE: BTB220

Course Outcome

CO1 - Understanding the multi-cellularity of organisms

CO2 - Role of extracellular matrix in signalling

CO3 - Various signalling pathways from the cell surface to the nucleus

CO4 - Cell signalling in plants

CO5 - Microbe-plant and insect-plant interaction.

Unit-I **12 Hrs**

Multicellularity: Role of Extracellular matrix - hyaluronan and proteoglycan. Matrix proteins and their receptors, adhesive proteins and cell junctions in multicellularity. Structure and function of plant cell wall

The importance of the matrix in signal transduction: Cell surface receptors as reception of extra-cellular signals, Amplification of signal during transmission - a quantitative study,Tyrosine kinase and tyrosine phosphatase, Cell membrane components and adapter proteins required for signal transmission, Upstream and downstream signal transduction without cell surface receptor activation, G-protein coupled signaling; the secondary messengers in signal transduction pathways cAMP, Ca^{2+}, Reactive Oxygen Species and Hypoxia Signalling, Apoptosis Signaling Transduction Pathway, PI3K/AKT Cell Survival Pathway.

Unit-II **12 Hrs**

Various signal transduction pathways from cell surface to nucleus: MAP kinase pathway, SAP/JNK pathway, p38 pathway, ERK pathway, NFkB pathway, Cell survival pathway, Wnt signaling pathway, Jak/Stat pathway, Smad pathway,TGF β Signaling, EGFR, VEGF And their Signalling, Cytoskeleton And Cell Signalling, Carbohydrate Recognition Signaling, MMPs And Cell Signalling, Cross talk among cell surface receptors, Cross talks among cytoplasmic components, Translocation of signal components during signal transmission, From cytoplasm to cell membrane, NF-κB Signaling from cytoplasm to nucleus, Cell cycle and its Signalling.

The end point of signal transduction--- gene transcription: Nuclear receptors and transcription factors in signalling, Signalling from single gene expression to multiple gene expression: Super array as a tool for the study of multiple gene transcription, Practical application of the signal transduction research, RNA Interference And Cell Signalling, Senescence and Its Signaling Pathways.

Unit-III **12 Hrs**

Signal transduction in plants: Cross-talk with the environment- wound and mechanical signalling - fatty acid signalling, peptide signalling, oligosaccharide signalling; protein kinases and signal transduction. Abiotic stresses - Dehydration-stress, salt-stress, cold acclimation, heat-stress

Role of active oxygen species (AOS) in plant signal transduction: AOS in plants, AOS as signal molecules, AOS-part of a signalling network.

Action of phytohormones: Multiple signals regulating growth and development of plant organs and their adaption to environmental stresses.

Unit-IV **12 Hrs**

Symbiotic plant-microbe interaction: Rhizospheric signals (PGPR) and early molecular events in the ectomycorrhizal symbiosis; Lipo-chito-oligosaccharides (LCO) signalling in the interaction between rhizobia and legumes; endophytes.

Recognition and defencesignalling in plant-microbe interaction: Resistance genes - gene-for-gene resistance; co-evolution and specificity of R genes; the TIR domain, the NBS domain; genetic organization of resistance genes; quorum sensing.
Plant-insect interaction: Induction of direct and indirect defence

Reference Books

1. Animal Cell Biotechnology – Methods and Protocols. Nigel Tenkins.
2. Molecular biology of the Cell –Alberts et al.
3. Molecular Cell Biology. 5th Edn. Lodish, H, et al., W H Freeman
4. Cell and Molecular Biology. Karp, J.JohnWiey and Sons In.
5. The Cell-Molecular approach. 4th Ed. Geoffrey M Cooper and Robert E Hausman.
6. Cell Biology- A Laboratory Handbook. 3rd Ed, 4th Vol, Julio E Celis

METABOLOMICS (SOFT CORE) – 48 Hrs

COURSE CODE:

Course Outcome

CO1-Understanding the basic metabolism of plants

CO2-Different pathways involved in secondary metabolite production

CO3-Altering the metabolic pathways by changing the precussors

CO4-Purification of useful secondary metabolites and their kinetics and dynamics

CO5-Applications in food and pharmaceutical industries

Unit-I **12 Hrs**

Plant Metabolomics: Developments and history of plant metabolomics, Nature and prospecting of metabolism-related secondary plant products, tools and techniques, production in culture: optimization; selection, hormonal kinetics for secondary metabolites, production, mechanism and control.

Unit-II **12 Hrs**

Production of secondary metabolites: Induction, Alkaloids, antitumor compounds, food additives, steroids and saponins, detoxification of secondary metabolites, production of secondary metabolites by bioconversion, genetic transformation for production of secondary metabolites, large-scale production in bioreactors, Metabolomics-assisted breeding.

Unit-III **12 Hrs**

Microbial metabolomics: Systems biology of microbial metabolism; microbe sensors, *In silico* metabolomes, Food and Applied metabolomics, Biomarker discovery. Experimental Approaches-Genome sequencing, Gene expression arrays, Nuclear Magnetic Resonance, Mass spectroscopy, Capillary electrophoresis, Two dimensional gel electrophoresis, Gene expression arrays, Pathway analysis, HPLC, Protein sequencing, Bench-scale fermentation, AFLP/RLFP analysis.

Unit-IV **12 Hrs**

Pharmacometabolomics: personalized medicine and future of health system, Pathways discovery and disease pathophysiology, Bioinformatics analysis of targeted metabolomics; Environmental metabolomics, Bioactive compounds and Pharmacognosy, Clinical Applications of Metabolomics, Nutrigenomics and Metabolomics, Novel Technologies for Metabolomics, Data Handling for Metabolomics.

Reference Books

1. V.Voet and J.G.Voet, Biochemistry, 3rd edition, John Wiley, New York, 2004.
2. A.L. Lehninger, Principles of Biochemistry, 4th edition, W.H Freeman and Company, 2004.

FOOD AND ENVIRONMENTAL BIOTECHNOLOGY (SOFT CORE) – 48 Hrs

COURSE CODE: BTB210

Course Outcome

CO1-Comprehensive insight into the fermented foods and enzymes in food industry

CO2-Obtain knowledge of functional foods, genetically modified foods and nutraceuticals.

CO3-Students will be able to understand current status of biotechnology in environment protection.

CO4-Understand the principles of bioremediation and significance of GMO to the environment.

Unit-I **12 Hrs**

Fermented foods, milk-based products, fermented vegetables, fermented meats, fish, beverages, vinegar, mould fermentation - tempeh, soysauce, rice wine.

Enzymes in dairy industry, cheese making and whey processing, impact of enzyme technology (protein hydrolysates, bioactive peptides), Enzymatic processing of fruit juices; role of enzymes in baking, meat and meat processing, phytase in animal feeds, DNA-based methods for food authentication, comparative methods of toxicity testing in (novel) foods, biological approach to tailor-made foods, application of generic technologies in food and nutritional sciences; anti-cancer components in foods.

Unit-II **12 Hrs**

Functional foods and Biotechnology: applying molecular, biochemical, cellular and bioprocessing concepts, use of specific phenolic metabolites from botanical species. Pre- and Pro-biotics, single cell protein, single cell lipids. Manipulation of fruit ripening process.

Food processing, principles and practices, food ingredients and processing aids from biotechnological processes, corn sweeteners, bacterial starter cultures, Food spoilage, preservation, mycotoxins in food commodities. Genetically modified foods, designer foods, Nutraceuticals, detection of GM foods.

Unit-III **12 Hrs**

Renewable and non-renewable resources, current status of biotechnology in environment protection. Characterization of waste. Waste water management: Bioreactors for waste-water treatment, Aerobic biological treatments, anaerobic biological treatments, treatment of industrial effluents-dairy, distillery, paper and sugar industries. Membrane-based waste water treatment.

Oil pollution – treatment with microorganisms.

Unit-IV **12 Hrs**

Bioremediation: Concepts and principles, bioremediation using microbes, in situ and ex situ bioremediation, biosorption and bioaccumulation of heavy metals.

Xenobiotics: Degradation capabilities of microorganisms with reference to toxicology, pesticides, herbicides, polyaromatic hydrocarbons.

Renewable energy: Relevance of GMO to the environment.

Solid waste management: Waste as a source of energy, biotechnology in paper and pulp industry, production of oil and fuels from wood waste, anaerobic and aerobic composting, vermiculture, biofuels.

Reference Books

1. Food Microbiology. Frazier, W. C. and Westhoff, D. C. Tata McGraw Hill.
2. Agriculture Bio-technology. Purohit. Agrobios India.
3. Food Bio-technology. Knorr, D. Marcel Dekker Inc.
4. Environmental Bio-technology. Jogand, S. N. Himalaya Publishing House, New Delhi.

PHARMACEUTICAL BIOTECHNOLOGY (SOFT CORE) – 48 Hrs

COURSE CODE:
Course Outcome
CO1-Rules and regulation regarding development of drugs
CO2- Study of Pharmacodynamics and pharmacokinetics of drugs
CO3-Different phases of clinical trials and drug toxicity studies.
CO4-GMP and GLP in production management and quality control and assessment

Unit- 1 **12 Hrs**

Introduction to pharmaceuticals and Drug development process: Introduction to pharma industry, history of the pharmaceutical industry, traditional pharmaceuticals of biological origin (animal, plant and microbial)biopharmaceuticals and pharmaceutical biotechnology, age of biopharmaceuticals, biopharmaceuticals: current status and future prospects.
Steps involved in drug development process, drug delivery systems, preclinical studies and principles practices, phases of clinical trials. Regulatory authorities in India, USA and Europe and Japan, prescription, non- prescription drugs and orphan drugs.-

Unit-II **12 Hrs**

Drug Receptors, Pharmacodynamics and pharmacokinetics.: Different types of drug receptors, second messengers (cAMP, Ca2+ and phosphoinositides) and their signalling mechanism, relation between drug concentration and respose, concentration effect curves, concentration- effect curves, relation between drug dose and clinical responses.Volume of distribution of drug, clearance, drug accumulation, bioavailability, alternative routes of administration and the first pass effect, therapeutic drug monitoring

Unit-III **12 Hrs**

Drug biotransformation and drug toxicity:The role of biotransformation in drug disposition, phase I metabolism (microsomal oxidation, hydroxylation, dealkylation), phase II metabolism (Drug conjugation pathway) CYP families, clinical relevance of drug metabolism, drug-drug interaction.
Mechanisms of toxicity, production of toxic metabolites, harmful immune response, idiosyncratic toxicity, contexts of drug toxicity, drug overdose, drug- drug interactions, pathology of drug toxicity. Cellular toxicity, organ and tissue toxicity.

Unit-IV **12 Hrs**

The drug manufacturing process and drugs of biopharmaceutical origin: Guides to good manufacturing practice, manufacturing facility. Clean rooms, cleaning, decontamination and sanitations (CDS), CDS of the general manufacturing area, CDS of the Process equipment, generation of purified water, water for injection, documentation, specifications, Concept and testing of pre- formulations & their parameters. Tablets: Compressed, granulation, coatings, pills and capsules, parenteral preparations, herbal extracts, oral liquids, Ointments. Processing and packing instructions.
Therapeutic enzymes: asparginase, DNAse, Glucocerebrosidase, galactosidase and urate oxidase, superoxide dismutase, Lactase.

Reference Books

1. Textbook of Pharmaceutical Biotechnology. Chandrakant Kokate, Pramod H.J, SS Jalalpure. Elsevier Health Sciences, 2012
2. Pharmaceutical Biotechnology: Concepts and Applications. Gary Walsh. John Wiley & Sons, 2013
3. Pharmaceutical Biotechnology, Second Edition. Michael J. Groves. Taylor & Francis, 2005

NON CREDIT COURSE

EMPLOYABILITY SKILLS MODULE

COURSE CODE:
Course Outcome
CO1- Concepts of corporate communication
CO2- English grammar skills
CO3- Develop strategies for negotiation and marketing
CO4- Personality development and interview skills
CO5- This course will enable students to learn about the project management, entrepreneurship.

Campus to Corporate: Transition from College to Corporate world; Perceptions v/s Real Corporate life; Working in Teams; Basics of corporate communication

Corporate & Office Etiquette: Elements of a good handshake; Visiting cards exchange & How to manage business cards; Small Talk & Networking; Basics dining etiquette

English Grammar: A quick round up: Nouns, Pronouns, Adjectives, Verbs, Adverbs, Tenses, Prepositions, Clauses, Subject and Predicate, Punctuations, Subject- verb agreement, Confusing prepositions, Missing Articles, Editing paragraphs

Negotiation Skills: Introduction to Bargaining and Negotiation; The Negotiation Process: Four Stages; An Analytical framework of Negotiation; Bargaining Approaches; Strategy for Value Added Negotiation

Selection & Interviewing Skills: Current market for talent & methods for attracting & sourcing; Best practices for different hiring situations - Campus, Market, Head hunter agencies; Selection process design & assessment centers; Effective interview

Personality Development: Self assessment: SWOT; Understanding Personality - Identifying different personalities; Levels of Human Learning; Change v/s Transformation; Sensitivity - Sharpen your senses; Creativity and Lateral thinking; Developing Positive Mental Attitude; Emotional Quotient; Handling Criticism; Positive Health; Food habits and Meditation; Goal setting - Creative Visualization - Law of Attraction; Living a created life - Personal Leadership

III Semester

BIOPROCESS ENGINEERING AND TECHNOLOGY (HARD CORE) – 48 Hrs

COURSE CODE:
Course Outcome
CO1-To have the **c**omprehensive insight into the different type of fermenter
CO2-To obtain knowledge of media design and industrial culture
CO3-Students will be able to understand different type of fermenter and bioreactor.
CO4-Understand the principles of downstream processing
CO5- To understand the enzyme technology and their applications in industry.

Unit-I **12 Hrs**
Basic principle of Biochemical engineering and Microbial Growth Kinetics:
General Introduction to metabolic pathways involved in microbial products, concepts of over production, primary and secondary metabolites, estimation of biomass. Isolation, screening and maintenance of industrially important microbes; Microbial growth kinetics, Strain improvement for increased yield and other desirable characteristics.
Batch culture, continuous culture, fed batch culture, the growth cycle, effect of nutrients, growth rate and cell cycle.

Unit II **10 Hrs**
Media design and industrial cultures: Introduction, typical media, Oxygen requirement, antifoams, media formulation, energy sources, carbon and nitrogen source, other components, media optimization , Media sterilization, Batch process (thermal death kinetics), continuous sterilization process. Sterilization of fermenter and other ancillaries, filter sterilization of air and media. Rheological properties of medium. Screening for industrial useful metabolites, maintenance of stock cultures

Unit III **10 Hrs**
Types of fermenters and bioreactors: design, control system, operation, optimization, control and monitoring of variables such as temperature, agitation, pressure, pH, online measurements and control, Scale up of bioreactors. Bubble column, airlift reactor, packed bed, fluidized bed, trickle bed, Membrane reactor, Photobioreactor, Solid state fermenter, Animal and plant cell bioreactors. Scale up and Scale down studies of bioreactors. Biosensor

Unit IV **16 Hrs**
Downstream processing (Recovery and purification of products) of biologicals: Separation of cells, foam separation, disintegration of micro organism, mechanical and non mechanical methods,flocculation, filtration, plate filters, rotary vacuum filters, centrifugation, Stoke's law, continuous centrifugation, basket centrifuge, bowl centrifuge, , membrane filtration, ultra filtration and reverse osmosis, chromatographic techniques, absorption, spray drying, drum drying, freeze drying.
Enzyme Technology: production, recovery, stability and formulation of bacterial and fungal enzymes-amylase, protease, penicillin acylase, glucose isomerase; Immobilised Enzyme and Cell based biotransformation steroids, antibiotics, alkaloids.

Texts/ References
1. Jackson AT., Bioprocess Engineering in Biotechnology, Prentice Hall, Engelwood Cliffs, 1991.
2. Shuler ML and Kargi F., Bioprocess Engineering: Basic concepts, 2nd Edition, Prentice Hall, Engelwood, Cliffs, 2002.

3. Stanbury RF and Whitaker A., Principles of Fermentation Technology, Pergamon press, Oxford, 1997.
4. Baily JE and Ollis DF., Biochemical Engineering fundamentals, 2nd Edition, McGraw-Hill Book Co., New York, 1986.
5. Aiba S, Humphrey AE and Millis NF, Biochemical Engineering, 2nd Edition, University of Tokyo press, Tokyo, 1973.
6. Comprehensive Biotechnology: The Principles, Applications and Regulations of Biotechnology in Industry, Agriculture and Medicine, Vol 1, 2, 3 and 4. Young M.M., Reed Elsevier India Private Ltd, India, 2004.
7. Mansi EMTEL, Bryle CFA. Fermentation Microbiology and Biotechnology, 2nd Edition, Taylor & Francis Ltd, UK, 2007.

GENETIC ENGINEERING (HARD CORE) - 48 Hrs

COURSE CODE:

Course Outcome

CO1-To have the **c**omprehensive insight into the different enzymes used in Genetic engineering lab

CO2-To obtain knowledge of construction of vectors

CO3-Students will be able to understand different type ofcloning methods.

CO4-Understand the principles of PCR& types

CO5- To know the different sequence methods

Unit I **10 Hrs**

Basics Concepts: DNA Structure and properties; Restriction Enzymes; DNA ligase, Klenow enzyme, T4 DNA polymerase, Polynucleotide kinase, Alkaline phosphatase; CRISPR- cas9, Cohesive and blunt end ligation; Linkers; Adaptors; Homopolymeric tailing; Labeling of DNA: Nick translation, Random priming, Radioactive and non-radioactive probes, Hybridization techniques: Northern, Southern and Colony hybridization, Fluorescence in situ hybridization; Chromatin Immunoprecipitation; DNA-Protein Interactions-Electromobility shift assay; DNaseI footprinting; Methyl interference assay

Unit II **10 Hrs**

Cloning Vectors: Plasmids; Bacteriophages; M13 mp vectors; PUC19 and Bluescript vectors, Phagemids; Lambda vectors; Insertion and Replacement vectors; Cosmids; Artificial chromosome vectors (YACs; BACs); Animal Virus derived vectors-SV-40; vaccinia/bacculo & retroviral vectors; Expression vectors; pMal; GST; pET-based vectors; Protein purification; His-tag; GST-tag; MBP-tag etc.; Intein-based vectors; Inclusion bodies; Methodologies to reduce formation of inclusion bodies; Baculovirus and pichia vectors system, Plant based vectors, Ti and Ri as vectors, Yeast vectors, Shuttle vectors

Unit III **6 Hrs**

Cloning Methodologies: Insertion of Foreign DNA into Host Cells; Transformation; Construction of libraries; Isolation of mRNA and total RNA; cDNA and genomic libraries; cDNA and genomic cloning; Expression cloning; Jumping and hopping libraries; Southwestern and Far-western cloning; Protein-protein interactive cloning and Yeast two hybrid system; Phage display; Principles in maximizing gene expression

Unit IV **22 Hrs**

PCR and Its Applications: Primer design; Fidelity of thermostable enzymes; DNA polymerases; Types of PCR – multiplex, nested, reverse transcriptase, real time PCR, touchdown PCR, hot start PCR, colony PCR, cloning of PCR products; Tvectors; Proof reading enzymes; PCR in gene recombination; Deletion; addition; Overlap extension; and SOEing; Site specific mutagenesis; PCR in molecular diagnostics; Viral and bacterial detection; PCR based mutagenesis, Mutation detection: SSCP, DGGE, RFLP, Oligo Ligation Assay (OLA), MCC (Mismatch Chemical Cleavage, ASA (Allele-Specific Amplification), PTT (Protein Truncation Test)

Sequencing methods: Enzymatic DNA sequencing; Chemical sequencing of DNA; Automated DNA sequencing; RNA sequencing; Chemical Synthesis of oligonucleotides; Introduction of DNA into mammalian cells; Transfection techniques; Gene silencing techniques; Introduction to siRNA; siRNA technology; Micro RNA; Construction of siRNA vectors; Principle and application of gene silencing; Gene knockouts and Gene Therapy; Creation of knock out mice; Disease model; Somatic and germ-line therapy- in vivo and ex-vivo; Suicide gene therapy; Gene replacement; Gene targeting; Transgenics; cDNA and intragenic arrays; Differential gene expression and protein array.

Text/References

1. S.B. Primrose, R.M. Twyman and R.W.Old; Principles of Gene Manipulation. 6th Edition, S.B.University Press, 2001.
2. J. Sambrook and D.W. Russel; Molecular Cloning: A Laboratory Manual, Vols 1-3, CSHL, 2001.
3. Brown TA, Genomes, 3rd ed. Garland Science 2006
4. Selected papers from scientific journals.
5. Technical Literature from Stratagene, Promega, Novagen, New England Biolab etc.
6. Genes, Benjamin XII , 2017

LAB-III (HARD CORE)

COURSE CODE:

Course Outcome

CO1 - Course objective is to introduce the students to the experiments related to plant and animal cell culture and its techniques.

CO2 – Understanding of enhancement of cell growth and analysis of industrially important molecules.

CO3 – Students will come to know the use Bioinformatics tools.

CO4 – Hands on training on techniques in the genetics engineering.

Practicals/ Experiments

1. Animal cell culture: preparation of media, culture and maintenance of cell lines, trypsinization
2. Culture of transformed cells
3. MTT assay for cytotoxicity
4. Western blotting and detection
5. Study of fermenter (demo)
6. Immobilization of yeast by calcium alginate, gel entrapment and assay for enzyme *invertase*
7. Assay of catalase.
8. Study of alcohol fermentation – alcohol from different substrates – estimation of alcohol content
9. Solid state fermentation
10. Determination of the activity of enzyme protease
11. Determination of the activity of enzyme amylase
12. Estimation of Vitamin E
13. Estimation of Vitamin C
14. Estimation of aminoacid by ninhydrin method
15. Preparation of MS media
16. Induction of callus
17. Micropropagation
18. Suspension culture- production of secondary metabolites
19. Preparation of synthetic seeds
20. Database search for nucleotide and aminoacid sequences using BLAST
21. Study of sequence alignment
22. Construction of trees/dendrogram using sequence analysis
23. Structure prediction using homology searches
24. RAPD
25. Transformation
26. Bacterial gene expression
27. RFLP mapping
28. Isolation of plasmid DNA from *E.coli*
29. Restriction digestion of DNA
30. DNA ligation
31. production of citric acid by *A.niger* by submerged fermentation.
32. Estimation of citric acid by titrametric method
33. PCR
34. Isolation of antibiotic producing actinomycetes from soil sample

CLINICAL AND ADVANCED TECHNIQUE IN BIOTECHNOLOGY (SOFT CORE) – 48 Hrs

COURSE CODE:

Course Outcome

CO1-Diagnosis of diseases using enzymes as markers
CO2-analysis of blood and urine sample to interpret the diseases
CO3-Study of metabolic disorders and their diagnosis
CO4- Clinical trails of designed drugs/ biomolecules
CO5-Tools of Histopathalogy, Immunotechnology, microarray and DNA chips in understanding the diseases

Unit I **16 Hrs**

Diagnostic Enzymology: Mechanisms of elevated enzyme activities. Some important enzymes – alkaline phosphates, creatine kinase, LDH, AST, ALT – isozyme changes

Blood: Composition, cells, functions of plasma proteins and lipo proteins in diseases. Disorders of hemoglobin – Thalassemia, sickle cell anemia. Anemias – Microcytic, normocytic and macrocytic.

Advanced methods in clinical analysis: Blood, urine and quantitative determination of metal ions in body fluids

Liver: Biochemical indices of hepatobiliary diseases. Bile pigments – formation of bilirubin, urobilinogen bile acids, jaundice – pre-hepatic, hepatic and post-hepatic; liver function tests, diseases of the liver – hepatitis, cholestasis, cirrhosis, Gallstones.

Unit II **8 Hrs**

Kidney: Assessment of renal function – creatine clearance, renal calculi, uremia, laboratory investigation of kidney disorders.

Cardiovascular Disorders: major cardio vascular system – Atherosclerosis – risk factors, pathogenesis. Diagnosis and prognosis

Disorders of Amino Acid and nucleotide metabolism: Gout Lesch – Nyhan syndrome, orotic acid urea phenyl ketonuria, alkaptonuria, maple-syrup urine.

Clinical trails of designed drugs/biomolecules.

Molecular detection of diseases, Amniocentesis

Unit III **12 Hrs**

Microscopy: Phase Contrast Microscopy, Fluorescence Microscopy, Confocal and Inverted Microscopy), Electron Microscopy (Transmission Electron Microscopy, Scanning Electron Microscopy)

Diagnostics and immunological techniques: applications of immunological and molecular diagnostic methods (RIA, ELISA, PCR, DNA finger printing) in forensic science and disease diagnosis. *In vitro* antigen-antibody reactions, Coombs' test, complement titration test (Direct and indirect), Immunoflourescence, Immuno-enzymatic and ferritin technique, Immuno-electromicroscopy. Immuno-electrophoresis, Western blot analysis. Hybridoma technology – Monoclonal and polyclonal antibodies and their application

Unit IV **12 Hrs**

Nanobio-technology: Introduction, types and synthesis of nanomaterial, protein – based nano structures, DNA-based nano structures. Applications of nanomaterials, nano biosensors, drug and gene diversity, disease diagnostics, cancer therapy, risk potential of nanomaterials.

DNA chip technology and micro arrays: Types of DNA chips and their production, hybridization, application of micro arrays on DNA chips.

Genomic research: Methods for whole genome sequencing, genome sequence data, e-PCR, genome sequence to annotation- methods for annotation of genome sequence.

Reference Books

1. Biochemistry – With Clinical Correlations. Devlin.
2. Clinical Biochemistry. Latner.
3. Principles of Instrumental Analysis. 5th Ed. Douglas A Skoog, James Holler and Timothy A Nieman.
4. Analytical and Preparative Separation Methods of Biomacromolecules. Hassan Y Aboul – Enein.
5. Microbiology – Principles and Explorations. 5th Ed. Jacquelyn G Black.
6. Genetic Engineering: Primose, S. B.
7. An introduction to molecular Bio-technology (Ed.) Wink.
8. Principles of gene manipulation and genomics. Primose, S. B. and Twyman, R. M.
9. Gene cloning and DNA analysis an Introduction. Brown, T. A. Blackwell Science Company.
10. Molecular Biology and Biotechnology. Walker, J. M. and Rapley, R. Panima Publishing Corporation.
11. Molecular Biotechnology – Principles and application of Recombinant DNA. Glicks, R. Bernard and Pasternak, J. Jack. Panima Publishing Corporation.
12. Molecular Biomethods Hand Book. Rapley, R and Walker, M. Jhon. Humana Press.
13. Genes (VIII edition) Benjamin Lewin, Pearson Education International

BIOSTATISTICS, BIOINFORMATICS AND BIOENTREPRENEURSHIP (SOFT CORE) – 48 HRS

COURSE CODE:

Course Outcome

CO1-Application of statistics to understand and analyse the experimental results of biological sciences
CO2-retrival of biological data
CO3-phylogenetic analysis
CO4-primer designing
CO5-drug discovery and molecular docking

Unit I **12 Hrs**

Statistical concept: Data structure, sampling methods, collection, classification and tabulation of data, graphical and diagrammatic representation, histogram, frequency polygon, frequency curve, bar graph, pie chart.

Measure of central frequency: **Mean, median, mode, mean deviation, standard deviation, standard error**

Types of distribution of data: Normal, binomial, Poisson, Z-test, t-test and ANOVA.

Correlation and regression

Unit II **18 Hrs**

Bioinformatics: Introduction, history, internet and bioinformatics, knowledge, discovery and data mining, problems faced in bioinformatics area, opportunities in bioinformatics, human genome project.

Biological databases and their management: database concept, introduction, history of databases, databases management systems, types of database, Codd rules, data normalization biological databases – introduction, application and its importance, biological database and their functioning, types of biological database, microbiological database, primary sequence database, carbohydrate database, RNA database, genome database, organism database, biodiversity.

Sequence database: Introduction, nucleotide sequence database, protein sequence database, the EMBL nucleotide sequence database, structure databases.

Bioinformatics software: Clustal V Multiple sequence alignment, Clustal W Version 1.7, Ras Mol, Oligo, Mol script, TREEVIEW, ALSCRIPT, genetic analysis software, Phylip.

Computational biology: Introduction, data mining and sequence analysis, database similarities searches, practical aspects of multiple sequence alignment, phylogentic analysis, predictive methods using nucleic acid and protein sequences, submitting DNA sequences to the databases.

Unit III **10 Hrs**

Innovation: Idea to enter into business, Designing and development of new products as per market demands and their future prospective. Needs of customer, branding, distribution, promotion and advertising.

Types of bio-industries and IPR: biopharma, bioagri and bioservices. IP protection & commercialization strategies- freedom to operate.

Accounting and Finance : Business plan preparation, contracts, partnerships, business feasibility analysis by SWOT, socio-economic costs benefit analysis; funds/support from Government agencies like MSME/banks and private agencies like venture capitalists:/angel investors for bio entrepreneurship; business plan proposal for virtual start up company. statutory and legal requirements for starting a company/venture; basics in accounting practices: concepts of balance

sheet, profit and loss statement, Valuation, Cash flow, double entry. Information technology for business administration and expansion. Technology transfer.

Incubation centres: Govt. (C-CAMP, KBITS, CFTRI) and Private incubation centres for start-ups.

Unit IV **8 Hrs**

Marketing : Market conditions, segments, prediction of market changes; identifying needs of customers; Market linkages, branding issues; developing distribution channels - franchising; policies, promotion, advertising; branding and market linkages for virtual start-up company.

Business Strategy & HR: Entry and exit strategy; pricing strategy; negotiations with financiers, bankers, government and law enforcement authorities; dispute resolution skills; external environment/ changes; avoiding/managing crisis; broader vision–global thinking; mergers & acquisitions.

Regulatory understanding:- GLP, GMP, GCP, PCB, IBSC, ISO

Bioentrepreneurship and case study: Importance of entrepreneurship; advantages of being entrepreneur - freedom to operate; introduction to bioentrepreneurship – biotechnology in a global scale; Scope in bioentrepreneurship; innovation – types, out of box thinking; skills for successful entrepreneur – creativity, leadership, managerial, team building, decision making, Risk assessment, opportunities for bioentrepreneurship- development programs of public and private agencies (MSME, DBT, BIRAC, Start-up & Make in India).

References:

1. Singh Narendra, Project management and control, (Himalaya publishing house)
2. Prasanna Chandra, Projects: Planning, Analysis, selection, implementation& review (Tata McGrow Hill)
3. P. GopalaKrishna& V.E. Rama Moorthy, Project management (Mac Millan India)
4. Chandra prasanna, proect preparation, Appraisal and Implementation (Tata Mcgrow Hill)
5. A. N. Desai, The dynamics of Entrepreneurial development and management (Himalaya publishing house)
6. Biostatistical Analysis. Zar J. H. Printice-Hall International.
7. Methods in Biostatistics. Mahajan, B. K. Smt. Hindu Mahajan
8. Bioinformatics. David W. Mount.
9. Bioinformatics A Practical Guide to the Analysis of Genes and Proteins Andreas D. Baxevanis and B. F. Francis Ouellette. A John Wiley & Sons, Inc., Publication.
10. Biostatistics. Daniel.
11. Handbook of Biostatistics A Review and Text. Christopher and Carvounis.

APPLIED BIOTECHNOLOGY (OPEN ELECTIVE) – 48 Hrs

Course Outcomes:

- Ability to understand the importance of biomolecules
- Understanding of importance of plant tissue culture
- Understanding of importance and applications of animal cell culture
- Ability to understand the importance and application of industrial biotechnology

Unit I **12 Hrs**

Scope of Biotechnology in India and Karnataka.

Structure of plant,animal and bacterial cells. Biomolecules and their importance.

Enzyme Biotechnology

Introduction to application of enzymes in industry: Food & beverage, detergent, textile pharmaceutical and leather.

Unit II **14 Hrs**

Applications of Plant Cell and tissue culture technology

Improvement of hybrids, encapsulated seeds, production of disease resistant, stress resistant plants, secondary metabolites from cell cultures

Transgenic plants for crop improvement, molecular farming from transgenic plants, edible vaccines. Bioethics in plant genetic engineering**.**

Unit III **10 Hrs**

Animal Cell Culture Techniques

Manipulation of reproduction in animals: Artificial insemination,embryo transfer, embryo splitting, embryo sexing

In vitro fertilization technology(IVF): Embryo cloning, embryonic stem cells Invitro-fertilization and embryo transfer in humans. Transgenic animals

Valuables products from animal cell culture (Tissue plasminogen activator, Blood factor VIII, erythropoietin.)

Hybridoma technology: Production of monoclonal and polyclonal antibodies and their applications. Bioethics in animal genetic engineeringcryopreservation, quantitation of cells, cytotoxicity assays.

Unit IV **12 Hrs**

Industrial and microbial biotechnology

Growth media, sources of nutrition, sterilization, design of fermenter, batch, fed batch and continuous culture.

Production of primary metabolites (vitamins, organic acids, alcohols and aminoacids). Production of secondary metabolites (antibiotics)

Biopesticides (Biological control of plant pathogens, pests and weeds.).

Biofertilizers (microbial inoculants)

Food Biotechnology – Genetically modified foods, Nutraceuticals, detection of genetically modified foods. Production of single cell proteins and mycoproteins.

Reference Books

1. Biotechnology. B. D. Singh
2. Biotechnology. R. C. Dubey

FUNDAMENTALS OF BIOINFORMATICS (OPEN ELECTIVE) – 48Hrs

Course Outcomes:

- Ability to use popular bioinformatics tools to generate biologically meaningful results
- Ability to interpret biological results generated by a bioinformatics tool
- Application of some basic models and algorithms
- The students will gain an understanding of the computational challenges (and their solutions) in the analysis of large biological data sets; they will understand how some of the commonly used bioinformatics tools work, how to use these tools effectively

Unit I **12 Hrs**

Introduction to Bioinformatics and Biological Database:

Introduction to bioinformatics, Review of Central Dogma, Genome organization -Prokaryotic and Eukaryotic. Overview of Genome Projects – Human genome project. Introduction to DNA and protein databases and their classification, file formats, information retrieval tools – Entrez, SRS, ARSA. Nucleotide and Protein sequence and structure databases (NCBI, EMBL, DDBJ and PDB). Focus on GenBank, UniProt, and Gene Ontology.

Unit II **12 Hrs**

Sequence Alignment and Database Similarity Searching:

Pairwise alignment: Alignment algorithm: Pairwise: Dot matrix method, Dynamic programming Method (Needleman-Wunsch & Smith Waterman), Scoring Matrices – PAM and BLOSUM, Database Similarity Searching: FASTA and BLAST. BLAST variants, Statistical parameters for BLAST output – e value, p value and Bit Score.

Unit III **12 Hrs**

Multiple sequence alignment:

Iterative, Progressive alignment. Application of MSA – 1. Phylogenetics – Phylogenetics Basics, Terminologies, Gene versus species phylogeny, Forms of tree representation: Maximum Parsimony and Distance methods 2. Gene prediction: Gene prediction in prokaryotes and eukaryotic 3. Protein Motif and Domain Prediction: Identification of Motif and Domains in MSA – PSSM and Profile HMMs.

Unit IV **12 Hrs**

Protein sequence analysis:

Analysis of Scalar parameters: Protparam and pepstats: Hydropathy analysis (Membrane protein prediction): Kyte-Doolittle plot, Helical Wheel representation. Secondary structure prediction, Protein structure building-Homology modelling (Comparative modelling only) – SWISS MODEL server and MODELLER, Protein Structure Visualization: Rasmol, Pymol, CN3D, Swiss PDB viewer, Chimera and Discovery studio visualizer

Applications of Bioinformatics: Bioinformatics in pharmacy: overview of drug discovery process, structure based and ligand-based drug design (CADD). Pharmacokinetics: absorption, distribution, metabolism, excretion and toxicity of drugs.

REFERENCE BOOKS:

1	David W Mount	"Bioinformatics sequence and Genome analysis", Cold Spring Harbor Laboratory Press, 2nd Edition, 2013, 9989332257358
2	Jin Xiong	Essentials Bioinformatics, Cambridge university press,3rd Edition, 2006, 9789335657325
3	Neil C. Jones and Pavel A. Pevzner	An Introduction to Bioinformatics Algorithms, MIT Press,5th Edition, 2005, 8789432449328
4	Steffen Schulze-Kremer	Molecular Bioinformatics: Algorithms and Applications, Walter de Gruyter, 4th Edition, 1996, 9789432449327
5	Attwood T K, D J Parry-Smith	Introduction to Bioinformatics, Pearson Education, 3rd Edition, 2005, 9789332447329
6	Michael R Barnes and Ian C grey	Bioinformatics for Geneticists, John Wiley & Sons Ltd, The Atrium, Southern Gate, Chichester, West Sussex PO19 8SQ, England
7	Rui Jiang, Xuegong Zhang. Michael Q. Zhang	Basics of Bioinformatics, Springer Heidelberg New York Dordrecht London,
8	Supratim Choudhuri	Bioinformatics for Beginners, Academic Press.
9	Peter Lake and Paul Crowther	Concise Guide to Databases. Springer London Heidelberg New York Dordrecht
10	Arthur M. Lesk	Introduction to Bioinformatics, Oxford University Press Inc., New York
11	Mahmood A. Mahdavi	Bioinformatics –Trends and Methodologies, InTech Janeza Trdine 9, 51000 Rijeka, Croatia
12	Catherine Hack and Gary Kendal	Bioinformatics: Current Practice and Future Challenges for Life Science Education: Biochemistry and Molecular Biology Education Vol. 33, No. 2, pp. 82–85, 2005
13	Teresa K. Attwood	The Babel of Bioinformatics, SCIENCE, Volume 290, Number 5491, Issue of 27 Oct 2000, pp. 471-473.

IV SEMESTER

PLANT BIOTECHNOLOGY (HARD CORE) – 48 Hrs

Course outcome

- Understanding of importance of plant tissue culture
- Ability to understand the concepts of adaptations of advanced technology in agriculture
- Understanding of concepts of plant transformation and transgenics technology
- Understanding of importance of IPR

Unit I **10 Hrs**

Plant tissue culture-General: Historical background: Requirements for in-vitro culture- Tissue culture laboratory, Preparation of media, sterilization. Conventional plant breeding and plant tissue culture.

Cell and Tissue Culture Technology: **Role of hormones in growth and development of plants, tissue-specific hormones. Callus Induction, Organogenesis, Somatic embryogenesis, cell suspension culture and synthetic seeds**

Somaclonal variations: Isolation of somoclonal variants, Factors affecting somoclonal variants – applications

Micropropagation: Propagation from pre-existing meristem, shoot apical meristem, shoot and node culture, micropropagation stages and applications

Unit II **15 Hrs**

Germplasm preservation: cryopreservation, cryoprotectant, warming rate and recovery, gene banks, applications.

Seed Health Technology

Introduction: Importance of Seed health, important seed-borne diseases; Seed Health diagnostics; Management of seed-borne diseases.

Haploid Technology: Methods of haploid culture, Factors affecting anther and microspore cultures, applications. Cytoplasmic male sterility in Indian Mustard.

Protoplast Technology: Isolation, purification and culture of protoplasts, protoplast fusion and somatic hybridization, applications of somatic hybrids/ cybrids.

Secondary metabolite production: Induction of secondary metabolites by plant cell culture, technology of plant cell culture for production of chemicals, biotransformation using plant cell culture. Bioreactor systems and models for mass cultivation of plant cells.

Unit III **7 Hrs**

Plant transformation techniques: Methods of gene transfer in plants, *Agrobacterium* mediated transfer- mechanism of DNA transfer, general features of Ti and Ri plasmids, role of *vir* genes, design of expression vectors, use of promoters and reporter genes; viral vectors, direct gene transfer methods- electroporation, microinjection, particle bombardment, selection of transformants, screening and field trials.

Unit IV **16 Hrs**

Transgenic plants: Herbicide resistance, resistance against biotic stress- bacterial, viral, fungal and insect resistance, abiotic stress, improved crop productivity, improved nutritional quality, transgenic plants for floriculture, Qualitative trait loci and marker studies.

Growth- promoting bacteria in plants: Biological nitrogen fixation, genetic manipulation for nitrogen fixation. Biocontrol of phytopathogens.

Molecular farming: Transgenic plants as production systems-production of alkaloids, steroids, colouring agents, flavoring agents, biodegradable plastics, industrial enzymes, therapeutic proteins, biopharmaceuticals, edible vaccines, plantibodies.

Intellectual Property Rights (IPR): IPRs and agricultural technology- implications for India, WTO, WIPO, GATT, TRIPS. Plant Breeder's Rights, legal implications, commercial exploitation of traditional knowledge, protection. Ethical issues associated with consumption of GM food, labelling of GM crops and foods.

Reference Books

1. Plant Signal Transduction. Scheel D and Wasterpack C. Oxford University Press.
2. Introduction to Plant Pathology. Strange R N. John Wiley and Sons Ltd.
3. Applied plant virology. Walkey. Chapman and Hall London.
4. Molecular Plant Pathology by Agrios.
5. Plant Tissue Culture Concepts and Laboratory Exercise. Trigiano R. N. and Gray, D. L. CRC Press.
6. Plant Tissue culture – Supplement-7. Lindsey, K. Springer International Edition.
7. Introduction to Plant Tissue Culture. Razdon, M. K. Oxford and IBH Publishing Co. Pvt Ltd.
8. Introductory to plant physiology. Noggle, R., Fritz, J. G. Prentice Hall of India Pvt. Ltd.
9. Plant Molecular Biology – A Practical Approach. Shaw, C. H. Panima Publishing Corporation.
10. A Laboratory Manual of Plant Biotechnology. Purohit. Publisher Agrobios.
11. Introduction to Plant Biotechnology. Chawla, H. S.
12. Practical Application of Plant Molecular Biology. Henry, R. J. Chapman and Hall.
13. Plant Biotechnology – Laboratory manual. Chawla, H. S. Oxford and IBH publishing Co. Pvt. Ltd.
14. Biotechnology. Gupta, P. K. Rastogi Publications.
15. Biochemistry and Molecular Biology of Plants. Buchanan, Gmissem and Jones.
16. Genetic Engineering of Crop Plants. Lyrett, G. W., Grierson, D.
17. Plant Molecular Biology. Grierson and S. N. Covey.

ANIMAL BIOTECHNOLOGY (HARD CORE) – 48 Hrs

Course outcome

- Understanding of different aspects of animal cell culture techniques
- Knowledge about the culture of specialized cells
- Understanding of concepts of tissue engineering and IVF
- Understanding of transgenic technology and transgenic animals

Unit I **10 Hrs**

Culture of animal cells: Advantages and limitations of tissue culture, aseptic handling, facilities required, media and cell lines. Primary culture: Isolation of mouse and chick embryos, human biopsies, methods for primary culture, nomenclature of cell lines, sub culture and propagation, immoretalization of cell lines, cell line designation, selection of cell line and routine maintenance.

Cloning and Selection: Cloning protocol, stimulation of plating efficiency, suspension cloning, isolation of clones, isolation of genetic variants, interaction with substrate, selective inhibitors.

Unit II **16 Hrs**

Cell separation and characterization: Density based, antibody based, magnetic and fluorescence based cell sorting. Characterization of cells based in morphology, chromosome analysis, DNA content, RNA and protein, enzyme activity, antigenic markers, cytotoxicity assays, cell quantitation, cell culture contamination: monitoring and eradication, cryopreservation.

Culturing of specialized cells: Epithelial, mesenchymal, neuro ectodermal, hematopoietic gonad and tumor cells, Lymphocyte preparation, culture of amniocytes, fish cells, confocal microscopy. Stem cell culture and its applications

Organic and embryo culture: Choice of models, organ culture, histotypic culture, filter-well inserts, neuronal aggregates whole embryo culture eggs, chick and mammalian embryos.

Unit III **16 Hrs**

Cell and Tissue engineering: Growth factors for *in situ* tissue regeneration, biomaterials in tissue engineering, approaches for tissue engineering of skin, bone grafts, nerve grafts. Hemoglobin based blood substitutes, bio antificial or biohybrid organs. Limitations and possibilities of tissue engineering.

***In vitro* fertilization and Embryo transfer:** *In vitro* fertilization in Humans, Embryo transfer in Humans, Super ovulation and embryo transfer in farm animals e.g: Cow.

Cloning of Animals: Methods and uses. Introduction, nuclear transfer for cloning, cloning from-embryonic cells, adult and fetal cells. Cloning from short term cultured cells: cloning of sheep, monkeys, mice, pets, goats and pigs. Cloning from long term cultured cells: Cloning of cows from aged animals. Cloning efficiency, Cloning for production of transgenic animals, gene targeting for cloned transgenic animals, cloning for conservation, human cloning: ethical issues and risks.

Unit IV **6 Hrs**

Transfection methods and transgenic animals: Gene transfer or transfection, transfection of fertilized eggs or embryos, unfertilized eggs, cultured mammalian cells, targeted gene transfer. Transgenic animals and applications: mice and other animals, sheep, pigs, goats, cows and fish.

The legal and socio-economic impact of biotechnology at national and international levels, public awareness. Biosafety regulations- guidelines for research in transgenic animals, public awareness of the processes of producing transgenic organisms

Reference Books

1. Anthony Atala, Robert P Lanza. 2002, Methods of tissue engineering, Academic press
2. Ian Freshney R. 2005, Culture of animal cells–A manual of basic techniques, John Wiley and Sons Inc. Hoboken, New Jersey
3. Animal Cell Culture – A Laboratory Manual. Frushney.
4. Animal Biotechnology. Ballinic, C. A., Philip, J. P and Moo Young, M. Pergamon Press.
5. Genetic Engineering of Animals. Puhler, A. VCH Publisher.
6. Methods of Tissue Engineering. Anthony Atala, Robert P. Lanza.
7. Animal Cell Biotechnology – Methods and Protocols. Nigel Tenkins.

PROJECT WORK/DISSERTATION (HARD CORE)

COURSE CODE:

Course Outcome

CO1-Review of recent research articles published in high impact journals and presentation by students.

CO2-Students do conduct review of literature followed by hands on training to do piece of research work.

CO3-They would be skill full to understand the experiment and interpret the result.

CO4-They get an idea to compile the data and present in the form of dissertation.

- Includes exhaustive review of literature on the topic selected, design of work, standardization of techniques and execution of work
- Compiling of the data generated in the form of thesis. Interpretation of the result correlating with the advanced information available in the literature.
- Research Paper presentation.